HAWAIIAN HAWK

Recovery Plan

HAWAIIAN HAWK RECOVERY PLAN

U.S. Fish and Wildlife Service

Portland, Oregon

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Associate Director, U.S. Fish and Wildlife Service

MAY 9 - 1984

Date

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Acknowledgements should read as follows:

The Hawaiian Hawk Recovery Plan, dated May 9, 1984, prepared by the U.S. Fish and Wildlife Service under contract with Curtice R. Griffin, Missouri Cooperative Wildlife Research Unit.

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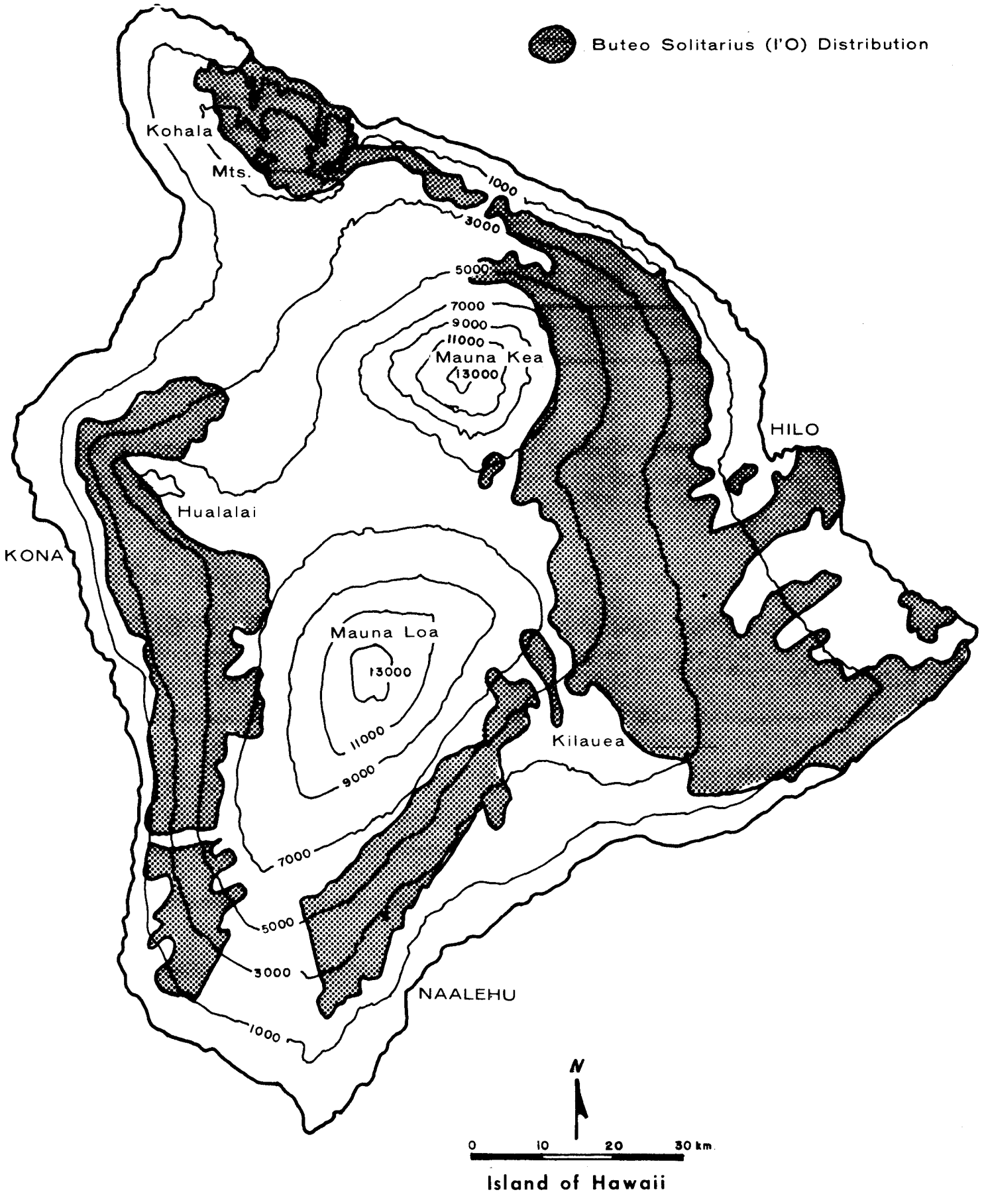
I. INTRODUCTION

The Hawaiian hawk or 'io (*Buteo solitarius*) is a small, broad-winged buteonine endemic to the Hawaiian Islands. While there have been eight observations since 1778 of 'io on the islands of Kauai, Oahu, and Maui (Banko 1980), the 'io is known to breed only on Hawaii. The species is widely distributed on the island, being locally common on the slopes of Mauna Loa, on both the windward and Kona coasts, and to a lesser extent on Mauna Kea (Figure 1, Berger 1981). It occurs from low to high elevations. This species was originally listed as endangered in 1967 (37 FR 4001; March 11, 1967). Recent research has provided much information on the life history, behavior, and habitat requirements of the 'io. Results from this research has been used to develop recovery recommendations, many of which have already been implemented and completed. This plan reviews the status of the 'io and proposes management practices, information and education activities, and research requirements which will lead to restoration of this species to delisted status. Although the English name is the officially recognized name for the species (American Ornithologists' Union 1983), the species will be referred to by its Hawaiian name, 'io, throughout this plan.



Island of Hawaii

Species Description

Distinct light and dark color phases exist for the 'io; however, there are intermediate plumages and much individual variation. This variation and dichromatic nature of 'io plumages, in addition to distinct, age-related differences in light phase hawks, has caused considerable confusion about 'io plumages (C. R. Griffin, unpubl. data)[1]. In general, adult, light phase 'io have a dark brown head and a dark brown, mottled back. The chest and belly are white with varying amounts of brown flaking on the sides of belly and upper chest. Immature, light phase 'io are like adults except the head and chest are buff white. Dark phase adults and immatures are dark brown all over, but the head and upper chest of immatures are mottled with tawny. In both color phases the cere (membrane at base of upper mandible), legs, and feet of immatures are bluish-green; adult ceres are bright yellow and legs and feet are pale yellow.

As in most other birds of prey, female 'io are larger than males. When 10 different morphological measures were combined, male 'io averaged 13% smaller than females, ranging from 27% less in weight to 9% smaller for extended foot length (C. R. Griffin, unpubl. data). This size difference is especially noticeable in the more stout tarsi and feet of females, which makes it relatively easy for an experienced

[1]Missouri Cooperative Wildlife Research Unit, University of Missouri, Columbia, Missouri 65201.

acting naturalist for Captain James Cook, (Cook 1784, Stresemann 1950). Although there were many Pacific expeditions that visited the Hawaiian Islands after Cook, the 'io was not reported again until the U.S. Exploring Expedition of 1840-41. Based on six months of exploring and collecting on Kauai, Oahu, Maui, and Hawaii, and information from native Hawaiians, Peale (1848), the expedition's naturalist, concluded that the 'io inhabited only the Island of Hawaii. Similarly, the two specimens of 'io collected by naturalists of the "Challenger" Expedition in 1876 were both secured near Hilo on the Island of Hawaii (Wilson and Evans 1890-99). However, Dole (1879) reported an observation of an 'io at Koloa, Kauai, and concluded that while the 'io was resident on the Island of Hawaii, the species also rarely occurred elsewhere. Olson and James (1982) reported on the fossil remains of one 'io on Molokai.

Observations and collection of specimens by five naturalists from 1887 to 1902 characterized the 'io of that period as ranging from low to high elevations and as resident in all major districts of the Island of Hawaii. From collections he made on Hawaii during 1887-88, S. B. Wilson considered the 'io rare, and believed that the 'io might also be found in the mountains of Maui (Wilson and Evans 1890-99). Munro (1944) stated that the 'io was fairly common in some localities in the 1890's. Similarly, Perkins (1903), from observing and collecting birds in several districts of the Island of Hawaii from 1892 through 1896, concluded that the 'io was common in some localities and not rare. He noted the hawk ranged from 30 to 1,500 m (100 to 4,900

feet) elevation in Kona, and in Kau from sea level to "high up in the mountains" on Mauna Loa. Henshaw (1902), who resided on Hawaii for eight years beginning in 1894, reported that the 'io was not rare, yet "nothing like so common as it used to be in the old days." Bryan (1915) believed the 'io was still fairly common in his day. Banko (1980) reviewed the historical information available on the distribution of 'io, and he concluded that it still occupies its entire historical range. There are little other historical data on population size or distribution which can be used as a baseline to compare with current estimates.

Present Status

More recent observers have recorded varying impressions of the status and distribution of the 'io. Munro (1944) stated nearly 40 years ago that the distribution of the 'io had probably not changed on Hawaii since the 1890's, but the populations had declined since earlier times.

Within Hawaii Volcanoes National Park, the 'io has been recorded for over 40 years. Morrison (1969) reported 64 sightings of 'io in the park from January 1967 through December 1968. He reported that the 'io could be found anywhere in the Park below 2,590 m (8,500 feet) where woody vegetation existed. He believed the normal range of hawks did not include barren sections, nor did they show a preference for any specific vegetation type within the park. Baldwin (1969), comparing

his data on 'io observations from 1938 through 1949 with those of Morrison, found that the number of 'io sightings increased in the 1960's. He suggested that 'io had probably increased and expanded their range within the park during the 30-year interval. Banko (1980) has compiled all 212 observations of 'io in the park, providing a long-term record.

From his unrecorded sightings of 'io in the Hamakua district of Hawaii from 1969 to 1971, P. Q. Tomich suggested the population at that time was stable or had increased relative to estimated hawk abundance in earlier years (field notes as cited in Banko 1980).

From observations made during a short birding tour, Orenstein (1968) estimated the total 'io population to be in the low hundreds. However, no basis for this estimate was given. Banko's (1980) work, mentioned above, reviewed all known 'io observations recorded during the two hundred years since European contact in 1778. In comparing the historical record with contemporary sightings, he concluded that the 'io was still present in all districts in which it had been reported, 80 or more years before. He also believed that the 'io had probably experienced a long-term population decline. However, he stated that conclusions concerning 'io population size and trend must be considered as tentative due to the lack of more historical information and the scarcity of current knowledge of the hawk. Today, the total 'io population is estimated to be between 1,400 to 2,500 hawks (C. R. Griffin and J. M. Scott, unpubl. data)[3], indicating that the 'io

is more common than previously thought. This estimate was derived from island-wide forest bird surveys conducted by the U.S. Fish and Wildlife Service, and radio telemetry studies of 'io home range sizes by the Missouri Cooperative Wildlife Research Unit (C. R. Griffin unpubl. data). Figure 1 shows the present 'io distribution based on sightings of hawks and known hawk territories.

Detrimental Factors

While there are factors (historically and presently) that are detrimental to the 'io, recent trends in population status are difficult to document. The field research conducted in recent years by the Missouri Cooperative Wildlife Research Unit and information obtained during the U.S. Fish and Wildlife Service, Hawaii Forest Bird Survey, are the baseline studies for the 'io. Population estimates of 'io prior to this work vary greatly in technique and effort and are not comparable. Thus, it is difficult to assess whether or not the 'io population may have changed.

A number of factors have been suggested as causing the decline of native Hawaiian birds (Warner 1968, Atkinson 1977, Berger 1981). Although none appear to be severely limiting, several are believed to be detrimental to the 'io and are discussed below.

[3]U.S. Fish and Wildlife Service, P.O. Box 44, Hawaii Volcanoes National Park, Hawaii 96718.

1. Harassment and Shooting

Harassment of nesting birds and shooting may be the most significant factors directly affecting the 'io today. Harassment of breeding 'io can result in nest abandonment, especially when the disturbance occurs prior to egg laying or during incubation (C. R. Griffin unpubl. data).

Disturbance of nests can also cause young to leave the nest prior to normal fledging. This can result in abandonment of the young by adults and/or the taking of young by predators. The current extent of these losses is unknown. However, with urbanization and access to the back country by plant pickers, marijuana growers, sportsmen and hikers, the problem can be expected to increase.

It has been suggested that the taking of forest birds for feathers and food by the early Hawaiians and the collection of birds for museum specimens by early naturalists may have played a major role in the extinction or local extirpation of some forest birds (Berger 1981). However, the cultural value of the 'io as 'aumakua' or guardian spirit and the unimportance of 'io feathers in Hawaiian culture suggest that these pressures by early Polynesians did not significantly affect the 'io population. Similarly, collections by early naturalists probably had little effect on the hawk population.

2. Habitat Destruction

Hawaii's forests have been drastically reduced as the result of cutting for firewood, timber, croplands, and pasture (Nelson 1967, Berger 1981). Most lowland forests were already modified before European contact (Kirch 1982). Today, most lowland forests have been converted to agricultural or urban uses, and introduced plants (primarily sugarcane, pastureland, and diversified crops) now dominate much of the island below 800 m (2,600 ft.) elevation. Upper elevation koa (Acacia koa) forests have also been drastically reduced as a result of logging and subsequent conversion to pasture. Widespread dieback of 'ohi'a (Metrosideros collina), Hawaii's most common native forest tree, has recently modified about 800 km^2 (310 mi^2) of forest habitat. Additional areas may be threatened with dieback, and forest bird population declines have been noted in dieback areas (Burgan and Nelson 1972). However, the occurrence of dieback is probably a recurrent natural phenomenon possibly related to changes in water level and soil quality (Mueller-Dombois 1977). Similarly, recent (1983) volcanic activity and lava flows have destroyed some forested areas containing 'io nests (C. R. Griffin, unpubl. data). Future urban development also threatens additional areas, particularly in forested regions around Hilo.

While habitat destruction and alteration have probably been the most significant factors affecting the 'io population,

it is difficult to assess the extent and the degree of their effect because of the scarcity of historical information on 'io population sizes. An assessment is further complicated because the 'io utilizes many of these highly modified habitats. However, the extensive destruction of native forests has probably reduced the quality of some 'io habitat available (C. R. Griffin, pers. comm.).

3. Predation

Several potential predators of the 'io or their eggs have been introduced to Hawaii. These include the domestic cat (Felis catus), Polynesian rat (Rattus exulans), black rat or roof rat (R. rattus), Norwegian rat (R. norvegicus), and mongoose (Herpestes auropunctatus). While several of these predators are known to prey on small native forest birds or seabirds in Hawaii (Kepler 1967, Berger 1981), there is no evidence that they are significantly affecting the 'io. However, all of these predators overlap the range of the 'io, and in the instances when a relatively young chick falls from the nest, it is likely the chick would be eaten by any one of these predators. Considering that adult 'io commonly take all these predators as prey, with the possible exception of the cat, it is very unlikely that they pose any major threat to the 'io population (C. R. Griffin, pers. comm.).

4. Avian Diseases

The endemic passerines of Hawaii appear to be very vulnerable to the two introduced diseases of avian pox and avian malaria (Warner 1968, van Riper et al. 1982). Both diseases are known to be transmitted by the introduced mosquito (Culex quinquefasciatus). Avian pox is also transmitted directly by contact among birds and by mites. Viable populations of Culex decline above 1,500 m (4,900 ft.) elevation, and there is a lower incidence of both pox and malaria in bird populations above this elevation (C. van Riper, pers. comm.)[4]. Considering that the 'io is widely distributed in both the mosquito-ridden low elevations and at elevations above 1,500 m, and that the birds breeds equally successfully at both (C. R. Griffin, unpubl. data), these two avian diseases are probably not serious threats to the 'io population. Additionally, all 75 blood smears taken from 32 different 'io at both low and mid elevations tested negative for the presence of avian malaria (C. van Riper, pers. comm.).

5. Environmental Contaminants

Organochlorine compounds have produced more devastating effects on raptor populations worldwide than have any natural factors or any other poisons (Newton 1979). However, relatively

[4]Cooperative National Park Resources Studies Unit, University of California, Davis, 95616.

few of these compounds are used in Hawaii (L. F. Pank, pers. comm.)[5], and only trace amounts have been found in 'io eggs and carcasses which have been analyzed (Berger 1981; C. R. Griffin, unpubl. data). Thus, organochlorine compounds do not appear to be a factor affecting 'io populations.

The potential for secondary poisoning of 'io due to the use of rodenticides in Hawaii is believed to be low. While rodenticides have been commonly used in Hawaiian macadamia nut orchards and sugarcane fields, there is no direct evidence of secondary poisoning of 'io. Considering the currently limited use of rodenticides in Hawaii and the highly sedentary and territorial nature of 'io, the present use of rodenticides in Hawaii is probably not a major factor affecting the 'io population (C. R. Griffin, unpubl. data).

Future use and impacts of rodenticides in Hawaii are unclear. Changes in agricultural practices and types of rodenticides used could possibly result in some impact to the 'io (D. P. Fellows pers. comm.)[6].

[5]U.S. Fish and Wildlife Service, 101 12th Street, Fairbanks, Alaska 99701.

[6]U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, P.O. Box 1747, Jamestown, North Dakota 58401.

Life History and Population Dynamics

'Io are very sedentary and remain in and defend their territories year around. 'Io vigorously defend the area around nests and, to a lesser degree, their hunting territory. Both adults readily attack any intruding hawks or owls, and they will also vigorously attack and hit humans in the vicinity of nest sites.

It is not known at what age sexual maturity is reached, but birds probably do not breed until at least 3 to 4 years of age. The acrobatic courtship display of males may be seen from winter through the spring. Nest building begins long before egg laying and continues into the nestling period. Prior to egg laying both the male and female assist with nest construction.

'Io nest from March through September. Most breeding females lay eggs in late April and early May. Clutch size varies from one to three eggs, but more generally only one egg is laid. Incubation by the 'io is long for buteonine hawks and lasts about 38 days. Both adults assist in incubation, but the female does the greater share of incubating while the male hunts. Human disturbance at nests is most critical prior to egg laying and may cause hawks to abandon that nest site. Continued harassment of incubating hawks can cause egg abandonment (C. R. Griffin, pers. comm.).

Hatching centers around the middle of June. The female broods the young chick almost continuously except when collecting and distributing food brought to the nest by the male. Hatching success is about 87 percent. After hatching, the male visits the nest only to deliver food. The female gives a high-pitched aggressive call at the male whenever he is in the vicinity of the nest. The female's tolerance of the male at the nest during incubation sharply contrasts to her markedly increased aggression towards him during the nestling period. In general, the male does almost all the hunting during the first 4-5 weeks of the nestling period, after which time the female begins leaving the nest area for progressively longer periods of time and begins providing a greater proportion of the food. The chick fledges at 8 to 9 weeks of age. Fledging success is about 70% of total eggs laid (C. R. Griffin, unpubl. data).

'Io nest success does not differ between forested sites dominated by ohia or ohia/koa overstory and sites dominated by exotic overstory, pastureland, or agriculture sites. Similarly, there are no differences in nest success between high and low elevation nests (C. R. Griffin, unpubl. data).

The length of post-fledging juvenile dependency for the 'io is exceedingly long compared to that of other buteos. Adults will continue to bring food to juveniles for several months after fledging. Juveniles also commonly occur in the natal territory begging for food over a year after fledging. As with other birds of prey, mortality

during their first year of life is probably higher than in subsequent years; however, the extended post-fledgling dependency and the non-migratory habits of the 'io probably reduce juvenile mortality.

'Io generally hunt for prey from a stationary position, and they readily pursue prey into cover. The 'io will also dive or "stoop" on prey, attempting to strike its quarry in mid-air or on the ground. Because the Hawaiian bat (Lasiurus cinereus) was the only land mammal native to Hawaii, birds were probably the primary prey available to the 'io when it colonized the archipelago. With the arrival of Polynesian and European man, many other potential 'io prey were introduced. Today, the 'io utilizes a wide variety of prey items, but its diet consists primarily of rats, mice (Mus musculus), and a wide assortment of both native and introduced bird species. Mongoose and insect prey can also comprise a significant part of 'io diet in certain locations or for certain 'io age/sex classes. The 'io is an opportunistic predator, and is both very versatile and adaptable in its feeding habits.

In summary, the life history of the 'io is well suited to the tropical climate of Hawaii. Small clutch size, long incubation and nestling periods, and extended post-fledgling dependency of 'io contrast sharply with temperate zone raptors. Hawaii's environment offers relatively stable food supplies which would allow 'io populations to remain near the carrying capacity of the habitat for this species. Hawk productivity appears adequate to maintain the

population, and other than man, there are no serious predators of adult hawks and their young.

Habitat Requirements

'Io are found from near sea level to approximately 2,600 m (8,500 feet). Banko (1980) suggested that 'io are relatively more abundant in windward than leeward forests, and gaps in their range appear in leeward Kohala, intermountain saddles and plains, and along the western flank of Mauna Kea. 'Io densities are also low in subalpine zones and mamane-naio (Sophora-Myoporum) forests (J. M. Scott, pers. comm.). Generally they do not occur in dry shrub land zones. 'Io are observed in both open or parkland forests and dense rain forests. They are also frequently seen in agricultural areas, such as papaya and macadamia nut orchards, and adjacent to sugarcane fields.

'Io nest in a wide variety of habitats, ranging from lowland agricultural areas and exotic forests to upper elevation pasturelands and native rain forests. Nests have been found at elevations from near sea level at 30 m (100 feet) to over 1,700 m (5,600 feet). Of 28 nest sites found in 1980-81, 15 were in ohia or ohia/koa forests, 5 in pasturelands, and 8 in areas dominated by exotic vegetation. There were a wide variety of understory types associated with these nest sites. Relative numbers of nests in each habitat type should not be construed as an indicator of 'io habitat preferences because all habitats were not sampled equally (C. R. Griffin, unpubl. data).

'Io nests have been recorded in six different tree species. Sixty percent of 'io nests found during Griffin's study (unpubl. data) were in ohia, the dominant tree in Hawaiian forests. This is similar to other buteos which apparently select nest trees based on the availability of large trees rather than tree species (Howell et al. 1978). The wide variety of tree species used by 'io further suggests that tree species may be relatively unimportant in nest-site selection.

The wide range of 'io nest site characteristics also makes it difficult to describe a typical 'io nest. They have been recorded nesting in both short (10 m) and tall (24 m) trees and constructing nests anywhere from 3.5 to 18 m from the ground. While the mean diameter at breast height (dbh) of nest trees was fairly large (50.3 cm), they nested in trees as small as 10.2 cm dbh. Of 24 nests, 9 (32%) were found on top of bird's-nest ferns (Asplenium nidus), 5 in trunk crotches, 3 each on large and medium-sized branches, and 4 on small branches at their juncture with the trunk (C. R. Griffin, unpubl. data).

'Io nests are typically bulky structures which are quite large for the size of bird. While nest size varied according to nest substrate, mean nest diameter was 64.7 cm. Bird's-nest ferns and tree crotches provide a stable platform for nest construction, and nests are used for many years and nesting materials added each breeding season. All nests contained nest cups (mean diameter = 23.9 cm) that were lined with green leaves (C. R. Griffin, unpubl. data).

While adult 'io remain largely in their breeding territories during the non-breeding season, juvenile 'io tend to move out of their natal territories beginning in the late fall and early winter. Immature birds appear to concentrate in habitats outside of active territories such as in agricultural areas such as papaya or macadamia nut orchards. Unharvested or discarded fruit in these agricultural areas attract large numbers of small exotic birds, rats and insects (primarily cockroaches) which are potential prey for 'io. However, prior to the next spring breeding season, most of these immature birds are driven from these areas by territorial birds whose home ranges overlap the orchards. Although it is not known where these immature 'io disperse to in early spring, they probably remain in habitats adjacent to active 'io territories (C. R. Griffin, pers. comm.).

Thus, today the 'io utilizes a wide array of both exotic and native habitats. The species has shown a remarkable ability to utilize highly modified habitats such as pastureland and some agricultural areas which have trees for nesting and perching. Replacement of some forest by exotic trees or agricultural crops such as macadamia nuts or papayas has produced habitat with a prey base (i.e., rats) perhaps even larger than pristine forests. However, extensive modification and reduction of native forests have probably reduced the general quality of available habitat to the species. Some upper montane koa forests have been converted to open pasturelands which probably do not contain adequate perching and nesting sites. While opening up some habitat

may increase the diversity and availability of prey species, habitat quality will decline when suitable nesting sites and perches become scarce.

Conservation Efforts

Status, Distribution, and Life History Studies

Because of the almost complete lack of biological information on the 'io, the U.S. Fish and Wildlife Service contracted with the University of Missouri through the School of Forestry, Fisheries, and Wildlife for the Missouri Cooperative Wildlife Research Unit to conduct a study of the ecology and life history of the 'io. The study began in April 1980, and the field work was completed in the fall of 1982. A final project report will be submitted in January 1985. This study, in combination with the Hawaii Forest Bird Survey conducted by the Patuxent Wildlife Research Center (USFWS) from 1976-1979 (Scott et al. 1981), has provided much information about the biology, status and distribution of the 'io which has been incorporated into this plan. Although data from these two research programs are still being analyzed, the preliminary information obtained from them have provided useful information in developing management guidelines for the 'io.

Surveillance for Environmental Contaminants

As part of the U.S. Fish and Wildlife Service (USFWS) contract, the Missouri Cooperative Wildlife Research Unit investigated the significance of environmental pollutants (e.g., pesticides, heavy metals, and rodenticides) as factors affecting reproductive success in the 'io. Cooperators in this segment of the study also included the USFWS Wildlife Damage Research Station, Hilo, Hawaii and Patuxent Wildlife Research Center. Abandoned 'io eggs and dead hawks were analyzed for organochlorine compounds and heavy metals. None or only trace amounts of these contaminants were found. Contaminants were, therefore, considered essentially nonexistent (O. H. Patee, pers. comm.)[7].

While zinc phosphide and fumarin have been used extensively as rodenticides in macadamia nut orchards and sugarcane fields in Hawaii (D. P. Fellows, pers. comm.), there are no records of secondary poisoning of 'io. No field experiments were conducted on the potential effects of these two rodenticides on 'io, but laboratory experiments have indicated that owls fed rats killed with fumarin appear to be unaffected by this rodenticide (Mendenhall and Pank 1980). Furthermore, zinc phosphide is considered relatively safe for non-target species due to its rapid decomposition into harmless products

[7]U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, Maryland.

(Hood 1972). Today, Hawaiian agriculture uses few anticoagulant rodenticides, and depends primarily on zinc phosphide for rodent control (D. P. Fellows, pers. comm.).

Public Education

Some effort has been made to inform the public about the 'io. In 1979, the U.S. Fish and Wildlife Service, in collaboration with the Hawaii Division of Forestry and Wildlife and other cooperating state and private organizations, prepared and distributed a colorful leaflet (No. 213) on the cultural importance of the 'io and its endangered status. The leaflet was distributed by the Cooperative Extension Service of the College of Tropical Agriculture and Human Resources, University of Hawaii.

Several short newspaper articles concerning the study of the 'io by the Missouri Cooperative Wildlife Research Unit appeared in the local Hilo paper and were useful in soliciting information from island residents about 'io nest observations. A longer full page article on the hawk appeared in the Honolulu Advertiser on September 29, 1981. The Conservation Council of Hawaii, in cooperation with several state agencies, local businesses, and private individuals, developed a large colorful poster of the 'io which was distributed to all schools in the state in recognition of National Wildlife Week 1982.

Captive Breeding

As of November 1982, four 'io were in captivity at the Panaewa Zoo, Hilo, Hawaii. Of these four 'io, two are partial wing amputees, and the other two hawks have been in captivity for over 6 years (L. Yoshina, pers. comm.)[8]. Unsuccessful breeding attempts by three of these hawks occurred in 1981 and 1982. In 1981, the first egg laid was removed and artificially incubated. A second egg was laid 20 days later, and it was left in the nest to be incubated naturally. Both eggs were infertile. In 1982, a different female was paired with the same male 'io which mated in 1981. One egg was laid and removed for artificial incubation. A second clutch of 2 eggs, one of which was without a shell, was laid 26 days later. The intact egg was replaced with an artificial egg for mechanical incubation about a week after laying when the female continued to show no interest in assisting the male with incubation. All eggs were infertile. Mr. Lloyd Yoshina, Director of the Panaewa Zoo, has a strong personal commitment to developing an 'io captive propagation program with the 'io now in the zoo's collection. However, there is no official support for his program and there are limited facilities at the zoo. The Honolulu Zoo has also expressed interest in captive breeding 'io, but they do not presently have birds to begin such a program.

[8]Panaewa Zoo, Department of Parks and Recreation, 25 Aupuni St., Hilo, Hawaii 96720.

II. RECOVERY

Objective

It is difficult to assess population trends of the 'io due to the lack of historical information on 'io numbers. Comparable data do not exist, and the historical status of the species can only be inferred from qualitative historical accounts.

Substantial research has been done on the basic biology of the 'io, and much has been learned about the habitat requirements of the species. Field workers have documented 'io distribution, and assessed several potential factors which may be limiting 'io numbers. The 'io population, now estimated at between 1,400 and 2,500 hawks, appears to be sufficient to maintain a self-sustaining wild population.

The primary objective of this plan is to assure that the present 'io population level is maintained. This can be accomplished by ensuring that inimical factors such as illegal shooting and excessive loss of key habitat components are minimized. The status of the 'io population should be monitored and programs developed to increase public awareness of the 'io and its importance in Hawaiian culture. Considering the present distribution and abundance of the 'io population, the species does not appear to be in danger of extinction. Further monitoring to determine how stable or secure the population

is, minimizing loss of habitat and unnatural mortality, and defining more precise criteria for delisting need to be pursued to meet recovery objectives. This strategy is outlined below.

Step-down Outline

Prime Objective: To ensure a self-sustaining 'io population in the range of 1,500 to 2,500 adult birds in the wild, as distributed in 1983, and maintained in stable, secure habitat. For purposes of tracking the progress of recovery, 2,000 will be used as a target to reclassify to threatened status. Criteria for complete delisting will be further developed (see task #7).

1. Determine present distribution and abundance of the 'io on Hawaii.
   - 11. Survey native forests and lowland areas. (completed)
   - 12. Conduct radio telemetry studies to provide additional data for estimating 'io population numbers. (completed)
2. Determine 'io habitat requirements.
   - 21. Describe habitat where 'io are found. (completed)
   - 22. Determine 'io nest site requirements. (completed)
   - 23. Determine habitat utilization patterns within various vegetational types. (completed)
3. Identify factors limiting the 'io population.
   - 31. Conduct ecological studies of 'io in different habitats.

311. Determine factors affecting 'io reproductive success. (completed)

312. Determine dispersal of juvenile 'io. (completed)

32. Determine effect of avian diseases on 'io. (completed)

33. Determine possible effects of environmental pollutants on the 'io. (completed)

34. Determine effect of predation by exotic species. (completed)

35. Determine incidence and overall effects of disturbance or taking of 'io by humans.

36. Determine specific food requirements of 'io. (completed)

4. Minimize or eliminate identified detrimental factors.

41. Maintain optimum or suitable habitat for feeding/nesting.

411. Promote the conservation of forest habitat.

412. Promote the protection of occupied territories in non-native forests and agricultural areas.

42. Protect the 'io from human-related mortality causes.

421. Protect nest sites from disturbance by people.

422. Enforce prohibition of taking.

423. Evaluate potential impacts of new use of pesticides.

5. Monitor 'io population status.

51. Check nest status at historical nest sites annually.

52. Conduct periodic surveys in suitable habitat.

6. Develop and implement a public information program to inform public agencies and private citizens about the 'io.

61. Develop and distribute brochures on the 'io. (completed in part)

62. Prepare basic educational programs specific to 'io.

63. Encourage captive rearing and display as an educational tool.

7. Determine appropriate status of this species and downlist or delist.

Narrative

Prime Objective: Surveys of historical 'io nest sites and population levels should be conducted to monitor the status of 'io and determine the long-term stability of the population. Maintenance of adequate distribution and abundance of forest cover is necessary to sustain the population. To increase public awareness of the 'io and its importance in Hawaiian culture, educational programs should be developed. Accomplishment of recovery actions to date needs to be evaluated to determine appropriate listing (including delisted) status of the 'io.

Many of the required tasks discussed below have been recently completed by the Missouri Cooperative Wildlife Research Unit (MCWRU) project. These tasks are thus not included in the implementation schedule (Part III) but are included in the following narrative to provide a complete description of the recovery program.

1. Determine present distribution and abundance of the 'io on Hawaii.

The first important step in the recovery plan is to determine the distribution and abundance of 'io on the island. Much has been accomplished to this end by the USFWS Hawaii Forest Bird Survey (HFBS) and the MCWRU 'io study. However, like most raptors, 'io are wide-ranging, secretive, and they occur at relatively low densities. These factors, in conjunction with the rugged, tropical Hawaiian environment, make an accurate count of 'io impossible. Periodic monitoring in the future will be covered in a later section.

11. Survey native forests and lowland areas (completed).

The HFBS systematically surveyed all native forested areas above 300 m on the Island of Hawaii during the summers of 1976-79. All bird species, including the 'io, were surveyed by the variable circular plot method (Reynolds et al. 1980) at over 7,500 census stations (J. M. Scott, pers. comm.). Although this technique is not considered suitable for density estimation of 'io, the survey data did contribute to the final population estimate. During 1980-81, the MCWRU surveyed 'io in lowland areas of the Puna, Hilo, and Hamakua districts by driving main roads. It was not possible to accurately survey 'io numbers by systematic road counts, but locations of occupied 'io territories were mapped. Nest searches were conducted in selected forested areas. All these data were synthesized to generate the 1,400 to 2,500 birds estimate.

12. Conduct radio telemetry studies to aid in estimating 'io population numbers (completed).

During 1980-81, the MCWRU conducted radio telemetry studies to determine "standard" home range sizes of 'io within different habitat types. These data in conjunction with the island-wide vegetation maps developed by the HFBS were used in estimating hawk densities in various habitats.

2. Determine 'io habitat requirements (completed).

To determine possible limiting factors on the 'io population, it is necessary to determine how hawks utilize available resources. Seasonal, sexual, and age specific differences in habitat utilization by 'io should be determined. Both of these tasks have been accomplished from survey work and radio telemetry studies conducted by the HFBS during 1976-79 and the MCWRU during 1980-81. This information will be presented in published form in the near future. Further information needs will then be evaluated.

21. Describe habitats where 'io are found (completed).

Surveys by both the HFBS and MCWRU (11.) provided data indicating what types of habitats are presently used by 'io. Hawk distribution and land ownership patterns have been determined.

22. Determine 'io nest site requirements (completed).

Locations of historical and new 'io nest sites found during the MCWRU study have been mapped. Habitat type and site characteristics were measured at each nest.

23. Determine habitat utilization patterns within various vegetational types (completed).

The MCWRU conducted radio telemetry studies to determine 'io home range size with regard to habitat type and breeding and non-breeding periods. Adult and juvenile post-fledging movements were monitored and 'io habitat utilization determined.

3. Identify factors limiting the 'io population.

Studies of the basic life history and ecology of the 'io were identified as important research needs. Information was needed on the species' nesting phenology, reproductive success, food habits, and juvenile mortality. Additionally, evidence of avian diseases and environmental pollutants as factors affecting 'io needed to be examined. All of these tasks have been achieved from ecological studies conducted by the MCWRU and other cooperators during 1980-82. Details of these studies will be presented in other publications. Populations will probably need to be periodically evaluated to detect changes in the impact of limiting factors.

31. Conduct ecological studies of 'io in different habitats.

During the 1980 and 1981 breeding seasons, the MCWRU conducted intensive observations of 'io nest sites from blinds. Automatic time-lapse movie cameras were also mounted at nests to provide information on hawk behavior. 'Io movements were monitored by radio telemetry.

311. Determine factors affecting 'io reproductive success (completed).

Reproductive success was measured at 'io nest sites, and causes of nesting failure assessed. Nest success was evaluated with regard to hawks utilizing native forest habitats versus habitats with exotic vegetation or agricultural lands. Success rates of nests at different elevations were also evaluated.

312. Determine dispersal of juvenile 'io (completed).

All young 'io encountered in nests were color banded. In addition, three young were radio tagged in 1980, and their post-fledging movements were monitored by ground triangulation from vehicles and aerial searches.

32. Determine effect of avian diseases on 'io (completed).

During the MCWRU study, blood smears were taken from 'io captured at various elevations. These slides were analyzed for evidence of avian malaria by study cooperator, Dr. Charles van Riper. Additionally, all captured 'io were examined for signs of avian pox and other abnormalities.

33. Determine possible effects of environmental pollutants on the 'io (completed).

Abandoned 'io eggs and hawks found dead during the MCWRU study were collected and sent to Patuxent Wildlife Research Center for analyses of pesticides and heavy metals. Information on hawk productivity, food habits, and foraging behavior also helped in determining potential contaminant problems. The

USFWS Wildlife Damage Research Center, Hilo, Hawaii, a study cooperator, assisted in evaluating the potential for rodenticide secondary poisoning. Results to date suggest environmental contaminants have not become a problem. Further work may be warranted in the future to monitor trends or if pesticide use increases.

34. Determine effect of predation by exotic species (completed).

Observations from blinds, nest checks, radio telemetry, time-lapse cameras, and food habit information all provide information on predator defense, and those factors which might be affecting reproductive success and 'io mortality.

35. Determine incidence and overall effects of disturbance and taking of 'io by humans.

Disturbance and take of 'io are considered potentially serious problems. However, little concrete evidence exists and the overall impact on the population remains unclear. The significance of these limiting factors needs to be clarified.

36. Determine specific food requirements of 'io (completed).

Food habits of 'io in different habitat types were determined through blind observations, nest checks, and time lapse camera studies during the MCWRU study. This information will aid in evaluating preferred habitats and limiting factors.

4. Minimize or eliminate identified detrimental factors.

A number of factors have been identified which could result in declines in the population. There are specific actions which can be taken to minimize the impact of these factors.

41. Maintain optimum or suitable habitat for feeding/nesting.

'Io nest densities appear similar in relatively undisturbed and highly disturbed forests, and immature 'io concentrate in a few exotic habitats, such as papaya fields during fall and winter. However, the extensive clearing of forests for sugarcane, pasture, and other agricultural uses has undoubtedly decreased 'io nesting habitat (C. R. Griffin, pers. comm.). Considering that the first three research-related steps of the recovery plan have been achieved, the conservation of remaining native forest habitat (primarily ohia and some koa) and protection of 'io nest territories are important subsequent steps in the recovery plan.

411. Promote the conservation of forest habitat.

The continued existence or improvement of forest ecosystems, especially the native upper montane forests, is important for the maintenance of a non-endangered, self-sustaining 'io population. Existing (native and exotic) lowland forests also provide important habitat for 'io. Preservation and maintenance of native forest ecosystems is crucial for the conservation of all Hawaii's unique flora and fauna, including 'io. This will require a coordinated effort by state and federal agencies, conservation groups, private foundations and landowners.

412. Promote the protection of occupied territories in non-native forests and agricultural areas.

Almost half of the 'io territories located during the MCWRU study are located in non-native forests or other exotic vegetation types (C. R. Griffin, unpubl. data). These territories appear to be productive and provide a significant contribution to the population. Efforts should be made to protect these territories.

42. Protect the 'io from human-related mortality causes.

Human related mortality factors are potentially among the most significant problems for this species. These problems can be controlled. Specific problem areas need to be identified and preventive measures implemented.

421. Protect nest sites from disturbance by people.

'Io nest site protection is accomplished primarily by making land managers more aware of 'io habitats and by controlling the use and development of areas where 'io nest. Conservation district laws and other land use zoning laws should be enforced to the maximum extent in the immediate areas surrounding known 'io nest sites. Thorough inventories for 'io nests should be conducted in conservation district zoned lands before any land use changes are initiated by the State Department of Land and Natural Resources. Buffer zones to protect raptors have been prescribed in U.S. Forest Service land-use plans since 1963 (Mathisen 1968). Such buffer zones

should be delineated around 'io nests to buffer hawks from disturbance. Data necessary to determine the dimensions of such a buffer zone should be available upon completion of the MCWRU project.

422. Enforce prohibition of taking.

Taking (shooting or otherwise harassing) of 'io has been reported. Although taking is difficult to control, an enforcement presence will help discourage such actions. Public education should also decrease the incidence of intentional or unintentional harm to 'io.

423. Evaluate potential impacts of changes in pesticide usage.

Although present use of pesticides does not appear to affect the 'io, changes in pesticide use in the future are causes for concern. Changes in agricultural practices could make rodenticides more accessible to 'io. New rodenticides (or other pesticides) with greater avian secondary hazard potential may become available. Action should be taken to evaluate all changes in pesticide types and use.

5. Monitor 'io population status.

Periodic checks of 'io nest sites and territories, and forest bird surveys should be conducted. These will provide data by which the long-term status and reproductive success of the 'io can be evaluated.

51. Check nest status at historical nest sites annually.

Approximately 20 historical 'io nest territories should be checked annually. An annual check will provide information on reproductive success and, more importantly, monitor hawk usage of an area. Annual nest checks will also facilitate the relocation and monitoring of old hawk nests in subsequent years and will help with locating alternate nest sites within territories. Nest checks should be made in mid or late July before young are ready to fledge.

52. Conduct periodic surveys in suitable habitat.

Surveys of 'io population numbers should be conducted in selected areas, islandwide. These large-scale surveys would provide an index of hawk numbers by which the long-term status of the 'io could be evaluated. This task can be accomplished by the U.S. Fish and Wildlife Service and the State Division of Forestry and Wildlife. Techniques most appropriate for this task are yet to be selected.

6. Develop and implement a public information program to acquaint government leaders and the public with the 'io.

The long-term maintenance of a self-sustaining 'io population depends largely on a public that is well informed of the value of Hawaii's natural resources in general, and the 'io in particular. A basic plan for disseminating educational materials should be developed for state-wide distribution. An informed public can be created through an aggressive educational effort.

61. Develop and distribute brochures on the 'io (completed in part).

A colorful brochure on 'io's cultural significance, status, distribution, behavior, and recovery program has been developed. However distribution of this brochure has been limited. Efforts should be made to promote wider distribution of this poster to schools, libraries, government agencies, land managers and other individuals.

62. Prepare basic educational programs.

A slide program on Hawaii's natural resources, including the 'io, should be developed for distribution to state and local organizations. Through coordination and cooperation with the State Department of Education and the Hawaii Science Teacher's Association, educational programs should be developed for use in the state's public and private schools. Educational efforts should also be directed at the local population on the Island of Hawaii, including ranchers and farmers.

63. Encourage captive rearing and display as an educational tool.

Captive display at such facilities as the Panaewa Zoo promotes public awareness of this (and other) native species. Removal of individual birds from the wild for such purposes will be considered on a case by case basis. Strict limitations must be maintained on removal of birds from the wild. However, public education on the life history and requirements of the 'io will help foster local acceptance for maintaining this species.

7. Determine more specific criteria for complete delisting.

Given the endemic, insular range of the species, the 'io population will always be relatively restricted. However, considering the current size and distribution of the 'io population, the species' high breeding success, the relatively low levels of predation and human disturbance, and the absence of environmental contaminants affecting the 'io, the population appears to be in a more secure condition than previously thought. This information, based on completed research, indicates that reclassification to threatened status may be warranted. Continued monitoring and the other items of this plan need to be pursued before complete delisting should be considered. More specific criteria need to be established for complete delisting.

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PART III

IMPLEMENTATION SCHEDULE

The implementation schedule is a summary of proposed actions and costs for the 'io recovery program. It is a guide to meet the objectives of the Hawaiian Hawk Recovery Plan, as elaborated upon in Part II, Action Narrative Section. This table indicates the priority in scheduling tasks to meet the objectives, which agencies are responsible to perform these tasks, a timetable for accomplishing these tasks, and lastly, the estimated costs to perform them. Implementing Part III is the action of the recovery plan, that when accomplished, will satisfy the prime objective. Initiation of these actions is subject to the availability of funds.

GENERAL CATEGORIES FOR IMPLEMENTATION SCHEDULES

Information Gathering - I or R (Research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Task Priority

Priority 1 - All actions that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

Key for responsible agency:

NPS - National Park Service
DLNR - Hawaii State Dept. of Land & Natural Resources
TNC - The Nature Conservancy
RES - U.S. Fish and Wildlife Service-Research
SE - U.S. Fish and Wildlife Service-Endangered Species
LE - U.S. Fish and Wildlife Service-Law Enforcement

IMPLEMENTATION SCHEDULE

General Category	Plan Task	Task #	Priority #	Task Duration	Responsible Agency FWS Region	FWS Program	Other	Fiscal Year Costs (est.) FY 84	FY 85	FY 86	Comments/Notes
I 1	Effect of disturbance by people	35	2	2	1	SE LE	DLNR	2,000	2,000		
M 3	Conserv. of native for.	411	2	continual	1	SE	DLNR TNC	To be determined To be determined To be determined			part of HFB Plan[1]
M 3	Maintain 'io territories in non-native habitat	412	2	continual	1	SE	DLNR DOA	To be determined To be determined To be determined			
O 3	Protect nest sites	421	2	continual	1	SE	DLNR	2,000 2,000	1,000 2,000	0 1,000	
O 2	Enforce prohibition of taking	422	2	continual	1	LE	DLNR	1,000 1,000	1,000 1,000	1,000 1,000	
I 2	Evaluate potential impacts of new pesticides	423	2	continual	8	RES		1,000	1,000	1,000	
I 6	Monitor nest success	51	2	continual	8 1	RES SE	DLNR NPS	1,000 1,000 1,000	1,000 1,000 1,000	1,000 1,000 1,000	

General Category	Plan Task	Task #	Priority #	Task Duration	Responsible Agency FWS Region	FWS Program	Other	Fiscal Year Costs (est.) FY 84	FY 85	FY 86	Comments/Notes
I 1	Conduct surveys	52	2	continual	8	RES		2,500	0	0	(included as a task in HFB Plan, costs would be covered after start up)
					1	SE	DLNR	2,500	0	0	
							NPS	1,000			
O 1	Dev. & distr. brochures	61	3	1	1	SE		3,000	0	0	(included as a task in HFB Plan, costs would be covered up after start up)
							DLNR	0	0	0	
							NPS	1,000			
O 1	Dev. basic educ. progr.	62	3	1	1	SE		1,000	0	0	(included as a task in HFB Plan, costs would be covered after start up)
							DLNR	1,000	0	0	
							NPS	1,000			
O 1	Promote captive rearing and display	63	3	continual	1	SE	DLNR				
O 4	Determine reclassification criteria	7	3	unknown	1	SE	DLNR	To be determined	To be determined		

[1] HFB Plan = Hawaii Forest Bird Recovery Plan

APPENDIX A

Agencies from Whom Comments Were Requested

(* denotes those agencies that responded)

* Chairperson
Board of Land and Natural Resources
State of Hawaii
1151 Punchbowl St.
Honolulu, Hawaii 96813

* Director, Pacific Area
National Park Service
300 Ala Moana Blvd.
Honolulu, Hawaii 96850

* Chairman
Board of Agriculture
State of Hawaii
1428 So. King St.
Honolulu, Hawaii 96814

The Nature Conservancy
1024 Nuuanu Ave., Suite 201
Honolulu, Hawaii 96817